official referees acting as aforesaid in the conduct and management of all references under this Act in which any such surveyor or official referee acting as aforesaid shall be a party, or shall be officially concerned or interested, and generally to advise the said surveyors or official referees acting as aforesaid on all matters of law connected with the execution of their duties."

By way of remuneration, this agent is to receive a per centage on the aggregate amount of fees "which shall have become payable" to each district surveyor, and to the referees for public buildings. This arrangement would probably be advantageous to three or four litigious district surveyors, but whether it would be palatable to those who find law not only undesirable but unnecessary, remains to be seen. As it now stands, it would necessarily tend to increase litigation and its consequence, bad feeling. Moreover, he could not satisfactorily act for referees and district surveyors too.

The schedules seem an improvement on those attached to the Act now in force. All buildings (except public buildings) are declared to be of one class, and party and external walls of each rate are to be of one thickness, preventing any 9-inch party wall in a third-rate building, and allowing it in a fourth-rate for the uppermost two stories only. An additional half-square in area is allowed to fourth-rates; and the public have an advantage in the removal of public buildings altogether from the supervision of the district surveyors. This would not only save the public from the payment of two sets of fees for the same building, which the present Act enforces, but would avoid the annoyance to architects of having their buildings first surveyed and passed by the district surveyor, and then pulled to pieces by the official referees, who may take a different view of the provisions of the Act.

We have but opened the ball.

ON THE NATURE AND PROPERTIES OF THE METALS USED IN THE BUILDING TRADES.

CAST-IRON—MALLEABLE-IRON—STEEL.

Having already* noted the chief sources whence the almost universally-diffused, and all-important, metal, iron, is derived, we shall now proceed to treat more particularly of its nature and properties, and especially of its three chief varieties, or states, of cast-iron, wrought-iron, and steel.

The appearance, tint, or glance of iron, in whichever of its states we take it,—whether in all the glitter and glory of 'cold steel,' in the homely shine of the kitchen poker, or in the still more dusky hue of the common cast-iron articles of daily use, is so familiar to one and all, that it is only, of course, *pro formâ* that we need here note, that it is of a greyish white with a shade of blue, and capable of assuming, in its form of steel, so high a polish as to excel in splendour every one of even the 'nobler' metals, such as silver, gold, or platinum. In tenacity and strength, too, though not in malleability, or even in ductility, it can be made to excel all other metals. Yet it *is* capable of being rendered both extremely ductile and remarkably malleable. It can be drawn out into wires finer than human hair, and can be beaten into tolerably thin plates and ribbons. In short, as remarked by one of our standard authorities, in treating of those manifold uses of this most precious metal which are, or ought to be, known to every one,—"It is capable of being cast into moulds of any form; of being drawn out into wires of any desired strength or fineness; of being extended into plates or sheets; of being bent in every direction; of being sharpened, hardened, and softened at pleasure. It accommodates itself, in fact, to all our wants, desires, and even caprices; it is equally serviceable to the arts and sciences, to war and peace; the same ore furnishes the sword, the ploughshare, and the scythe, the pruning-hook, the needle, and the graver, the spring of the Geneva watch, or of the ponderous locomotive, the chisel, the chain, the anchor, the compass, the cannon, or the bomb."

* Vide p. 197.

But in speaking of its tenacity and its other simpler properties, we must be a little more explicit in detail. Its matchless tenacity in its other states than that of mere cast-iron is such, that a wire of wrought-iron, drawn out, by its extreme ductility, through orifices gradually diminishing in calibre down to the 0·787 part of a line in diameter, has been found capable of supporting a weight of about 550 lbs.; and a wire of tempered steel, according to Parkes, has been found to carry double the weight of an ordinary wire. One of British iron, an inch in diameter, and estimated, in relation to Swedish, only as 348·88 to 549·25, is stated by Murray to have sustained weights without breaking till raised to 25 tons 6 cwt. The tremendous strength of wire ropes may thence be all the more readily conceived. Invaluable as such properties are, however, there is another perhaps still more peculiar and practically important, namely—welding, which it, and it almost alone amongst metals, possesses, and that in high perfection. Were it not for this peculiarity, indeed, in which platinum amongst metals, and sodium amongst metalloids, alone at all resemble it, the great infusibility of wrought-iron would sadly diminish its vast utility. The metal when pure and malleable requires the highest temperature of a wind furnace to make any impression on its extreme infusibility. The fusing point of cast-iron even, which *will* fuse, ranges to 3480° Fahrenheit; and it is very doubtful whether at *any* temperature it can be made to boil, as many metals readily do. But wrought, or malleable, or fibrous iron, at a bright red heat, is soft and pliable, and, by hammering, will so interweave its fibres, those of one piece with those of another, as to become spliced, as it were, completely, into one continuous whole. Such is a feasible enough idea of the nature of welding. But it is, in fact, by a species of welding that the very *particles* of wrought-iron, are first of all worked into mass as such. In that curious process, 'puddling,' cast-iron while fused in a proper reverberatory furnace, is stirred or puddled, and thus exposed to the air and flame till the whole mass heaves, burns blue, grows tough, less fusible, and actually falls at length into a *dry powder*. Then the fire is urged so that the pulverulent mass again *agglutinates* at the *welding* heat, and thus, as it were molecularly rewelded, is worked up into masses, and squeezed through rollers into 'malleable iron,' as afterwards and elsewhere more particularly pointed out. The oxides of iron, too, thus yield, with combustible or carbonaceous matter, in the furnace, a metallic spongy mass for subsequent compaction into malleable metal. Such, probably, was every where the earliest mode of treating iron ores, as, indeed, is still the case with ruder nations. But along with this agglutinative property, iron is equally singular in forming, at a high heat, that correlative compound with carbon—cast-iron, whence, again, the purer and more malleable metal is prepared by puddling, and by means of which the separation from the ore of every thing extraneous is facilitated.*

* The effect of puddling being apparently so important, one would think there could be but one opinion of its advantage and necessity. Yet we find the son of a very eminent practical authority on this particular subject, namely the late Mr. Mushet, not only broaching another opinion on the point, but one the very reverse of that which has been universally held ever since the process itself was introduced by Cort, in 1783. "Which," says Mr. R. Mushet, "is the most preposterous dogma in the present science of iron-making?—1. The use of the refinery?—2. The use of the puddling-furnace?—or, 3. The use of hot-blast in smelting the rich blackband ironstones? I am aware that, in attacking these *time-honoured abuses*, I am uttering blasphemy against the powers that be in iron-making, and earning for myself the character of an insane visionary; but a few short years will show that I am correct in my views; and pig-iron, instead of being subjected to the various tortures of refining, puddling, &c., will be at once passed through the rolls, or placed under the hammer! not, indeed, overloaded as at present with a quantity of carbon, which, as soon as it has by skilful management been got into the iron, must next be got out again; but pig-iron cast with the object in view to which it has to be applied—viz., rolling into bars; and for which it can only now be made *very indifferently fit* by two laborious, expensive, and destructive operations—refining and puddling. The merits of the puddling process, in so far as facility and quantity in the production of bar-iron were concerned, were so immense *in comparison* with those of the former processes employed, that up to this moment iron manufacturers have apparently never considered whether it is possible to supersede the puddling process by a direct method of operation. It is not for me to attempt to enlighten the mighty men of iron, whose greatness, like that of King Og, seems to be measured by the extent of their make in iron—Og being celebrated for his iron *bedstead*, and the eminent iron-masters for the extent of their *beds* of iron; but I would ask, what is the mighty obstacle which really exists to the production of iron fit for rolling out at once into bars." If there be anything in this rather startling heterodoxy, our quotation of it may assist in ripening the fruits of reflection on it.

In connection with these peculiarities of iron, we may here note that it is well known that hammering long continued destroys that very malleability which it at first contributed so essentially to mature. Dr. Black suggested from this that the hammering, which we all know *will* evolve even red heat from cold iron, expelled too much of the heat latent in (or, as we may very properly term it, constitutional to) the malleable state of the iron, or to that state essentially necessary, and he accordingly conceived metals to possess malleability in proportion to their latent (or constitutional) heat. From some facts too related by Sir James Hall, it appeared that at certain temperatures, above the welding heats, all iron falls to pieces under the hammer, even as at first applied, or independently of long continuance, and that this happened at different heats in the different varieties of the iron of commerce,—in cast iron at about 15° Wedgwood,—in steel at 30°,—Swedish iron at 50° to 60°,—and Siberian at 100°. In estimating the respective degrees of tenacity in iron, and investigating other kindred peculiarities of a most interesting and practically important order, such facts might be of great use. It is very generally believed for instance, that mere long continued or reiterated vibration, or other continuous or recurrent motion, will, *in like manner with heat or hammering* as above, at length of itself destroy the tenacity or toughness of wrought-iron—a question, this, that cannot too soon be investigated and decided, in connection with a series of just such facts and experiments as those to which attention has now been drawn. The very fact itself, indeed, that so singular a change in iron as that from the ordinary to the *magnetic* state, can be induced by merely stroking, tapping, or other gentle percussion or friction, or even by the mere continued pressure of gravitation or magnetic posture in the sphere, may prove the proposed subject of investigation to be no idle or groundless one; for if hammering or percussion, heat, or even mere friction or pressure can produce changes so remarkable, so *may* vibration,—all of these, in fact, being merely different modes of subtle force, operative on, and *undermining*, or otherwise altering, the connections of the more or less minute particles, crystlets, polarcles, molecules, or atoms of the mass.

The texture of iron, like most of its other properties, varies much with its varieties of state, or with the methods of working it. Though, in bars, or wire, it seems to be longitudinally fibrous, yet when kept *long* red hot, it acquires a crystaline texture, and has a tendency to cuboidal fracture. This, too, doubtless, involves the nature of that very change which takes place in the undermining of its tenacity by *high* heat, even though not of *long* duration. The specific heat of wrought-iron is 0.11379 (Regnault); that of cast-steel, 0.11848; and that of cast-iron 0.12728.

The affinity of iron for oxygen is so great that it will unite with it to form rust at all temperatures, withdrawing it even from water, liberating the hydrogen. Yet it is very singular that the oxide of iron thus produced is reducible again to the metallic state by the very hydrogen which it had liberated. Nevertheless, the spongy mass thus obtained, when exposed to air, has its affinity for oxygen still so strong and undiminished that it takes fire even spontaneously and burns into oxide again. More than that, the black, or rather deep blue protoxide itself, when carefully produced and dried out of access to air and then suddenly exposed to it, will still burn further, and that too spontaneously, glowing like tinder, into brown peroxide, or common rust. In an atmosphere of oxygen, iron burns with vivid brilliant scintillations, produced by merely tying a little cotton to the end of a piece of wire and plunging it in while the cotton is in flames; and D'Arcet showed that combustion